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PATENT SPECIFICATION 1,188,016

DRAWINGS ATTACHED.

Inventor:—BERNARD FRANK ARMSBY.

1,188,016

Date of Application (No. 52464/67) and filing Complete Specification: 17 Nov., 1967.

Complete Specification Published: 15 April, 1970.

Index at acceptance:—B3 D8; H1 K(41Y, 417, 424, 52Y, 538, 59Y, 591, 60Y, 603, 607, 61Y, 611, 619).

International Classification:—B 24 c 1/04.

COMPLETE SPECIFICATION.

Improvements in or relating to Bevelling.

We, STANDARD TELEPHONES AND CABLES LIMITED, a British Company, of STC House, 190 Strand, London, W.C.2, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of bevelling sharp edges such as may occur either at the periphery of a surface or in relief detail formed in the surface and finds particular but not exclusive application in the bevelling of such edges occuring in semiconductor devices. This method includes 'air abrasion', which term for the purposes of this specification is defined to mean a method of eroding material from a workpiece by directing on to it a jet of air or other suitable gas which has abrasive particles entrained in its stream.

According to the invention there is provided a method of bevelling the sharp edges at the periphery of a surface, or the sharp edges of relief detail formed in a surface, including the steps of coating the surface with a liquid masking layer which can be caused to solidify to a resilient solid and which is partially drawn away from the sharp edges by the effect of surface tension, to which may be coupled the effect of shrinkage occurring on solidification, to leave a thinner layer in the regions of the sharp edges than elsewhere, of causing said liquid layer to so solidify, and of air abrading the surface whereby the thinner parts of the masking layer are preferentially eroded away thereby selectively exposing the regions of the sharp edges to abrasion.

The method of the invention relies for its functioning on the deposition on the workpiece of a liquid layer which subsequently solidifies to a resilient layer of non-uniform thickness. The lack of uniformity is caused by the effects of surface tension drawing the liquid away from any sharp edges, and this effect may be augmented by any shrinkage which may occur on solidification of the layer. Due to the non-uniformity, the compliance of the layer is different in different parts of the surface; in the thicker portions it renders the layer largely resistant to air abrasion, but in the thinner portions, those in the regions of sharp edges underlying the layer, it is not sufficient, and hence these regions are preferentially eroded away exposing the underlying sharp edges to abrasion.

One example of where bevelling is required at the periphery of a semiconductor device is given by the requirement to protect a junction edge against destructive reverse breakdown. The protection obtained by such bevelling is described in our Patent Specification No. 1,013,424. In other applications bevelling may be applied to the edges of a moat or channel etched in the surface of a semiconductor. The technique of masking and etching a substrate using a thin stainless steel mask through which channels are air abraded into the underlying substrate provides the substrate with channels which have sharp edges under the mask and hence the substrate is particularly suitable for subsequent bevelling of these sharp edges by the method of this invention.

The features of the invention will be evident from the following description of the method of bevelling embodying the invention in its preferred form where the method is applied to bevel the sharp edges of channels etched in the surface of a semiconductor

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substrate. The description refers to the accompanying drawings, in which:

Figs. 1 and 2 show stages in producing a bevel on the sharp edges of a channel formed in the surface of a semiconductor substrate,

Figs. 3, 4 and 5 show examples of the use to which the bevelling of Fig. 2 may be put.

With reference to Fig. 1 a semiconductor substrate 1 is formed with a channel whose walls 2 meet the top surface 3 of the substrate in sharp edges 4. It is these edges which are required to be bevelled. The substrate is covered with a masking layer 5 of a rubberised paint. The paint used for this purpose is a stopping-off paint designed to be used in electro-plating. In order to be able to deposit the paint uniformly, and taking into account the small size of the substrate, the paint is thinned and filtered through a wire mesh before being sprayed on to the substrate through an atomiser. The effect of surface tension is to make the thickness of the deposited layer non-uniform inasmuch as the paint is partially drawn away from the regions of sharp edges 4. This effect may be enhanced by any contraction of the paint occurring on solidification. After the paint has been applied, instead of curing it at an elevated temperature, it is simply allowed to dry at room temperature for about one hour. If the paint is cured as for its electro-plating applications or allowed to dry for a period exceeding a few days its resilience is impaired and it does not prove so effective a mask for the purposes of air abrasion. After drying, the substrate is air abraded by scanning it with a fine alumina powder, typically 27μ powder, entrained in the air stream issuing from the jet of air abrasion machine such as described in our Patent Specification No. 983,683 or in our Patent Specification No. 1,185,555 (filed in pursuance of our co-pending Patent Application No. 52463/67).

In the thicker portions the layer 5 is resistant to abrasion but in the regions near the sharp edges it is broken down and eroded away exposing the underlying substrate to abrasion and this in its turn starts being eroded. After the layer 5 has been punctured in the regions of the sharp edges the amount of bevel that can be obtained is not limited by the thickness of layer 5 in adjacent regions for although these adjacent regions may be effective in protecting the underlying parts of the substrate from attack from above it does not protect them from the scouring action of air abrasion attacking from the side. Hence more material is removed from the edges extending the depth of the bevel with each scan of the abrasive jet. After a few scans the substrate may have the appearance depicted in Fig. 2.

Examples of the use to which this sort of bevel may be put are illustrated with reference to Figs. 3, 4 and 5. In Fig. 3 a semiconductor substrate 30 having a channel formed in its surface has a surface layer 31 of opposite conductivity type which follows the contours of the surface. The presence of a bevel serves to separate this surface layer into three separate regions, one in the channel and the other two on either side of it. Fig. 4 shows a variation of the configuration of Fig. 3 in that the surface layer of opposite conductivity type 41 to the substrate 40 lines only the base and side walls of the channel and the junction comes to the surface of the semiconductor near the edges of the channel. The whole surface of the substrate has then been plated with a metallic layer 42 to which it is subsequently required to make terminal connections. Until the bevel is made, the metal layer has the effect of short-circuiting the junction, but by bevelling to a sufficient depth to expose the junction the short is removed.

If the bevelling of these channels were to be effected by the normal method of photolithographic masking and etching it would be necessary to devise some means of ensuring accurate registry of the mask with the channels. However this problem of registry, which can be quite a severe problem especially in a device having a number of curvilinear channels such as illustrated at 51 in Fig. 5, is entirely eliminated by the method of bevelling according to this invention.

If the substrate has first been given an etch resistant coating it is possible to remove more material after air abrasion by etching. Alternative to the use of a special etch resistant coating underlying the abrasion resistant coating, it is possible to use a rubberised paint which is both abrasion resistant and etch resistant.

It is to be understood that the foregoing description of specific examples of this invention is made by way of example only and is not to be considered as a limitation on its scope.

WHAT WE CLAIM IS:—

1. A method of bevelling the sharp edges at the periphery of a surface, or the sharp edges of relief detail formed in a surface, including the steps of coating the surface with a liquid masking layer which can be caused to solidify to a resilient solid and which is partially drawn away from the sharp edges by the effect of surface tension, to which may be coupled the effect of shrinkage occurring on solidification, to leave a thinner layer in the regions of the sharp edges than elsewhere, of causing said liquid layer to so solidify, and of air abrading the surface whereby the thinner parts of the masking layer are preferentially eroded away thereby selectively exposing the regions of the sharp edges to abrasion.

2. A method of bevelling as claimed in claim 1 wherein a rubberised stopping off paint is used to provide the masking layer.

3. A method of bevelling substantially as hereinbefore described with reference to the accompanying drawings.

4. A semiconductor device containing portions bevelled by the method as claimed in any preceding claim.

S. R. CAPSEY,
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For the Applicants.

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Fig. 1.

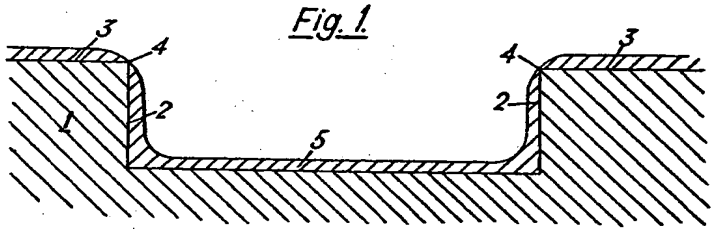
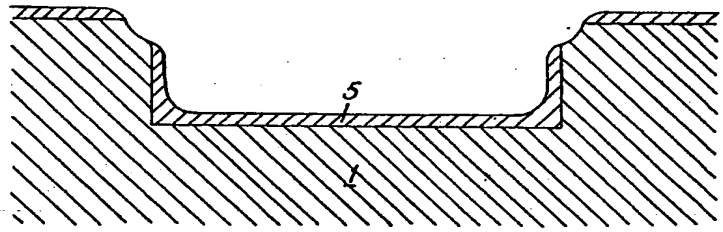


Fig. 2.



1188016 COMPLETE SPECIFICATION
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Sheet 2

Fig.3.

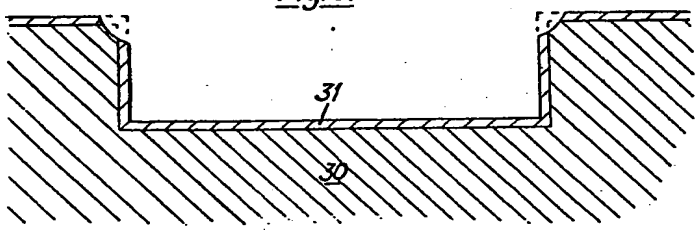

Fig.4.

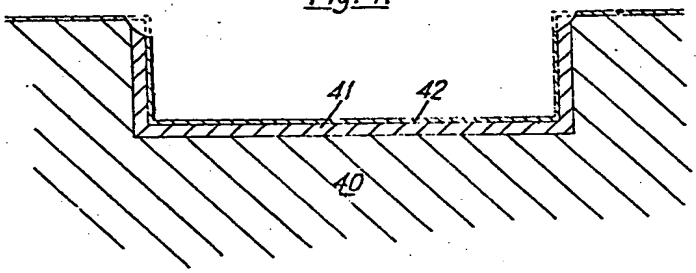

Fig.5.